Level 1: Entry

Coral Reefs, Satellites, and Sea Surface Temperature (SST)

Summary

Grade Level: 6-8

Teaching Time:

Two 45-minute periods

The study of coral reefs will provide an authentic learning environment for students to access and interpret data collected by remote sensing satellites. The activities in these lessons will prepare students to monitor corals using real data as a way to examine what is happening to the health of corals on a global scale.

Objectives

- Students will identify coral reef ecosystems, their locations, and their importance.
- Students will examine temperature ranges needed for coral reefs to survive.
- Students will use false-color maps to read sea surface temperature data collected from satellites.
- Students will color code a map to represent isotherms.

Focus Questions

- What are we investigating and why should we care?
- Where are coral reefs located?
- What tools do I need to examine coral health?

Climate Literacy

Climate is determined by the long-term pattern of temperature and precipitation averages and extremes. Climate descriptions can refer to areas that are local, regional, or global (CL4A)[4].

4 *Climate Literacy: The Essential Principles of Climate Science*, Second Version: March 2009. http://www.globalchange.gov/browse/educators

Background (Teacher)

Coral reefs face numerous hazards and threats both globally and locally. In this study, we will focus on the threat of mass coral bleaching produced by rising sea surface temperatures.

Students begin their study of coral bleaching by identifying the location of coral reefs, typically in climate zones between 30° N and 30° S latitudes. They will also establish why coral reefs are naturally adapted to conditions in these zones, where water temperatures typically range from 18°C to 29°C.

Once students locate the reefs, they will look at sea surface temperature (SST) data to identify any patterns and changes in water temperature.

To monitor SST on a large scale, students will use data from instruments on orbiting satellites that measure infrared radiation from the ocean surface. These data can be represented on maps. Students will map temperature zones by examining lines on the maps, called isotherms, which connect areas of the same temperature. They will use colors to represent temperature zones, producing what is called a false-color map, to make it easier to see and measure relative differences in SST.

Once students learn to access and read satellite-generated maps of SST, they will use them to identify and track stresses causing coral bleaching.

Vocabulary

Climate - the long-term 30-year average of conditions in an area—atmosphere, oceans, ice sheets—described by statistics, such as means and extremes.

Coral Reef - a seafloor biological community that forms a solid limestone (calcium carbonate) structure, built upon many generations of dead coral. The predominant organisms in most reef communities are corals.

False-Color Map - an image that uses colors, rather than true appearance, to represent differences in measured values. The color is "false" in that the land, water, or other surface shown is not really the color on the map.

Isotherm - a line connecting areas of equal temperature.

Range - determined by upper and lower limits. All living things have a range of conditions in which they thrive. Corals thrive within a temperature range of 18°C to 29°C.

Remote Sensing – measuring the property of something without touching it.

Sea Surface Temperature - the average temperature at the uppermost layer of the ocean, only a few millimeters deep. Sea surface temperature, often referred to as SST, can be globally monitored through satellite remote sensing.

Weather - The specific conditions of the atmosphere at a particular place and time, measured in terms of variables that include temperature, precipitation, cloudiness, humidity, air pressure, and wind.

Activity 1: Identifying and Mapping Coral Reef Locations

Materials

- **Computer, whiteboard, or projector**
- **Student Master 1.1: Calling Citizen Scientist Researchers!** (1 per student)
- **Teacher Master 1.1: World Coral Reef Locations saved to computer**
- **Student Master 1.2: World Coral Reef Locations** (1 per student)
- **Teacher Master 1.2: Monthly Average Sea Surface Temperature**
- **Student Master 1.3: Monthly Average Sea Surface Temperature (with Isotherms)** (1 per student)
- **Colored pencils**

Preparation

If you have access to a computer and projector, you can display a color version of the SST maps you create online. Use the following steps:

1. Visit www.datainthecclassroom.noaa.gov, and find the Coral Bleaching module.

2. Follow the link to "Get Data."

3. You will be requesting data for the region displayed on the map. Using the controls on the left side of the map, zoom out until the map displays the entire Earth.

3. Select "Sea surface temperature" under "Which dataset?"

4. Using the form, specify the date 15-July-2014.

5. Select “Map” on the menu labeled "Which view?"

6. Select an output format: Image.

7. Click the "Get Data" button.

8. Save the map to your computer. On a PC, right click with the mouse and select "Save as...." On a Mac, hold down the Ctrl key and click with the mouse.

Alternatively, you can save a master from page XYZ for display using a projector.

Procedure

1. Pass out a copy of **Student Master 1.1: Calling Citizen Scientist Researchers!** to each student. Have the students read the invitation to

study coral health. Explain that that they are being invited to find evidence to identify reasons why coral reef health is declining on a global scale. In order to do this, they will learn where coral reefs are located and explore the biotic and abiotic characteristics of their environment.

2. Project an image of **Teacher Master 1.1: World Coral Reef Locations**. Point out that coral reefs are distributed around the planet, but only in limited locations. Ask students the following questions about reef locations and record student answers.

Where do the reefs seem to be located?

Possible answer:

- *waters near the shore or on either side of the equator*

Where do corals seem to be absent?

Possible answers:

- *large areas on the west coast of South and Central America, and the west coast of Africa*
- *upper part of the North American continent, Greenland, Asia, and to the south near Antarctica*

3. Distribute **Student Master 1.2: World Coral Reef Locations** to each student. Challenge students to use latitude and longitude to locate the listed coral reefs on the map. Review how to read latitude and longitude.

- x axis = longitude, degrees east and west of the prime meridian.
- y axis = latitude, degrees north and south of the Equator.

Ask students to answer the questions regarding coral reef location at the bottom of the master.

Review with students the answers to the questions:

- Where are corals located?
- Between what latitudes do most corals live?

Possible answers: Corals live in the tropical climate zone, which is determined by the distance north and south of the Equator (between 30° N and 30° S latitude).

Then ask:
Why do you think corals are limited to certain locations on the planet?

Possible answers:

- *water too cold or too hot*
- *water too shallow*
- *water too deep*
- *not enough sunlight*
- *too much salt*
- *too much sediment in the water*

Tell students that they have hit on some of the major physical factors that limit coral reef development: depth, light, salinity, sedimentation, the emergence of coral into air, and temperature.

4. Display **Teacher Master 1.2: Monthly Average Sea Surface Temperature** on a whiteboard or computer screen. Explain that the map has been generated using real data collected from orbiting satellites using a technology called remote sensing.

Tell students that they will compare and relate the maps of coral reef locations with the map of sea surface temperatures.

Introduce the map's key features by pointing them out on the screen:

- x axis = longitude, degrees east and west of the prime meridian.
- y axis = latitude, degrees north and south of the Equator.
- Isotherms are connected lines of equal temperature.
- The temperatures indicated by each isotherm are measured in degrees Celsius.
- On the color map, the color key at the right also indicates temperatures in degrees Celsius.

5. Tell students that they will create a color-coded SST map, also known as a false-color map. They will then answer questions that demonstrate their ability to read and interpret the false-color maps.

Give each student a copy of **Student Master 1.3: Monthly Average Sea Surface Temperature**. Ask students to use colored pencils to color code the regions on the map defined by each isotherm. The isotherms are already labeled in degrees Celsius. Students should begin by choosing colors to represent bands of temperature on the scale to the right of the map. Traditionally, warmer temperatures are represented in shades of red while cooler temperatures are blue or purple.

Ask students to use their completed maps to answer the four questions on the master. Review the answers with students.

Answers:

1. b. degrees north and south of the equator

2. 28°C

3. 24°C

4. 23°C - 27°C

6. Compare the SST map that students colored with the SST map you displayed.

Ask: How are the maps alike and how are they different? Hint: Look at the size of the areas of high temperature.

7. Discuss the following questions:

How can using satellite data help researchers to study water conditions over time?

Possible answer:

- *Track changes in SST from one year to another and look for patterns.*

Why is it important for researchers to look at data for more than one year to determine sea surface temperature changes?

Possible answer:

- *Using SST satellite data from different time periods can show trends and how the climate changes over time.*

8. Discuss the following reflection questions (Level 1 Focus Questions):

What are we investigating and why should we care?
Where are coral reefs located?
What tools do I need to examine coral health?

9. Once students are comfortable reading maps, they can use the online "Get Data" tool to examine more sea surface temperature data. If you have Internet access in class, go to datainteclassroom.noaa.gov and repeat the Preparation procedure with different dates to generate and discuss new maps.

Have students consider changes that occur in sea surface temperature at different times of the year, such as winter compared to summer.

Tell students to generate additional maps from different seasons and discuss.

Student Master 1.1

Calling Citizen Scientist Researchers!

Dear Citizen Scientist Researcher:

Are you fascinated by coral reefs where every surface, nook, and cranny is bursting with life? These oases of life are found near the Equator, where sunlight and sea surface temperature are fairly even throughout the year.

But there's a problem! Something is happening to the health of coral reefs around the planet. Scientists estimate that 10 percent of all coral reefs are degraded beyond recovery and 30 percent are in critical condition and may die within 10 to 20 years.

What's going on?

Is the problem caused by local threats, such as overfishing, destructive fishing practices, nutrient runoff, sedimentation, and anchors from boats ripping into the corals? Or is something much bigger at work, a global threat of coral bleaching linked to rising sea surface temperature?

Why should you care? You may not even live near a coral reef or the ocean!

The health of coral reefs can be used to study changes in our climate over time. Changes in the climate may influence us all, no matter where we live. As you research coral health, see if you can identify more reasons why you should care about the reef systems.

What can we do?

We need you to investigate. Your challenge is to use real-time sea surface temperature (SST) satellite data and in situ, right on the coral reef, observations to find evidence to answer this question:

What are the consequences of rising sea surface temperature on coral reefs, and why should you care?

How can you get started?

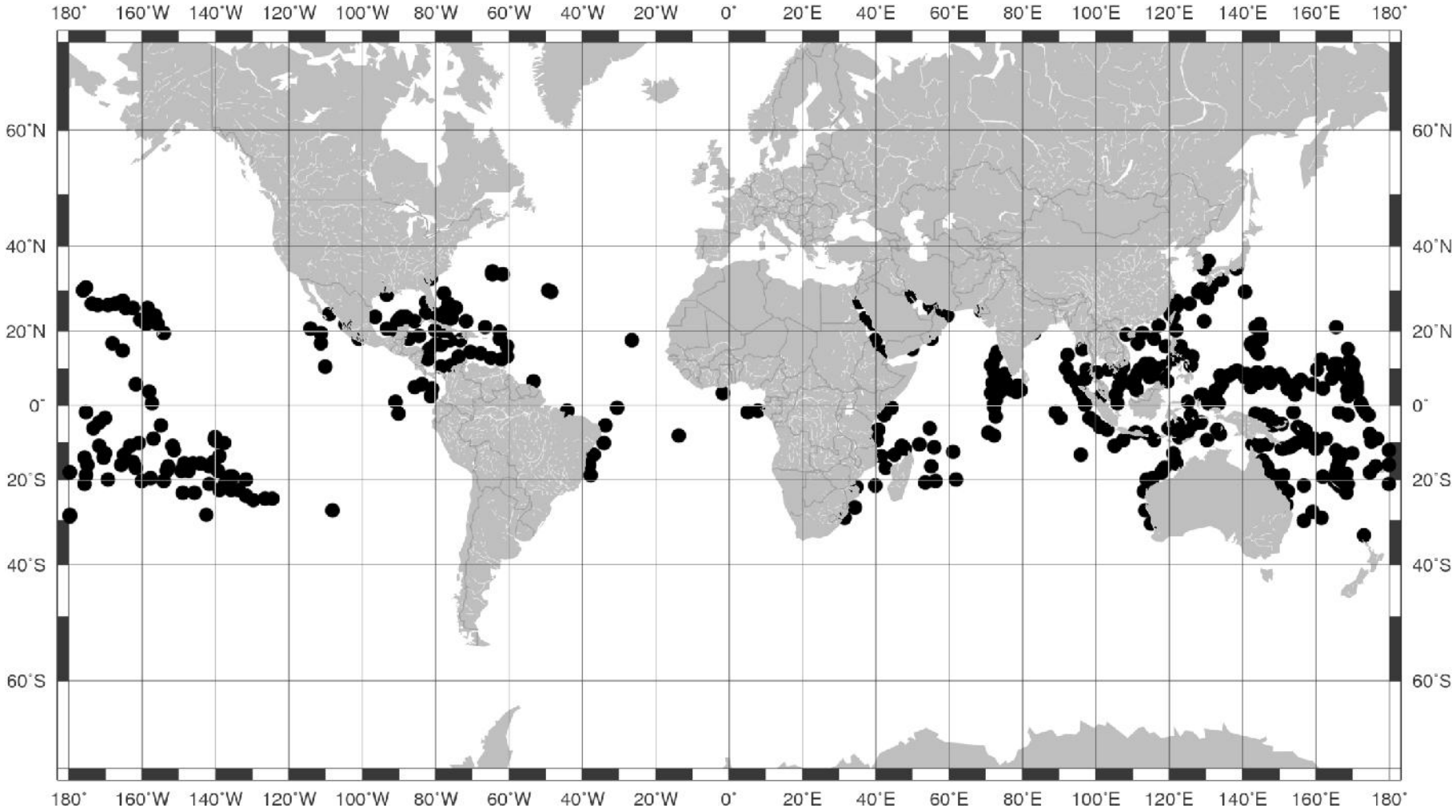
You will analyze and interpret data streams from instruments on orbiting satellites, which measure infrared radiation from the ocean surface. These powerful tools are at your fingertips, allowing you to monitor corals and figure out what is happening to coral health over time.

You will collect evidence for this scientific problem by learning to monitor globally, locally, and regionally using the power of satellites, scuba gear, maps, and your love of coral reefs. Are you ready?

Welcome to the NOAA Ocean Data Education (NODE) Project. Get ready to start exploring!

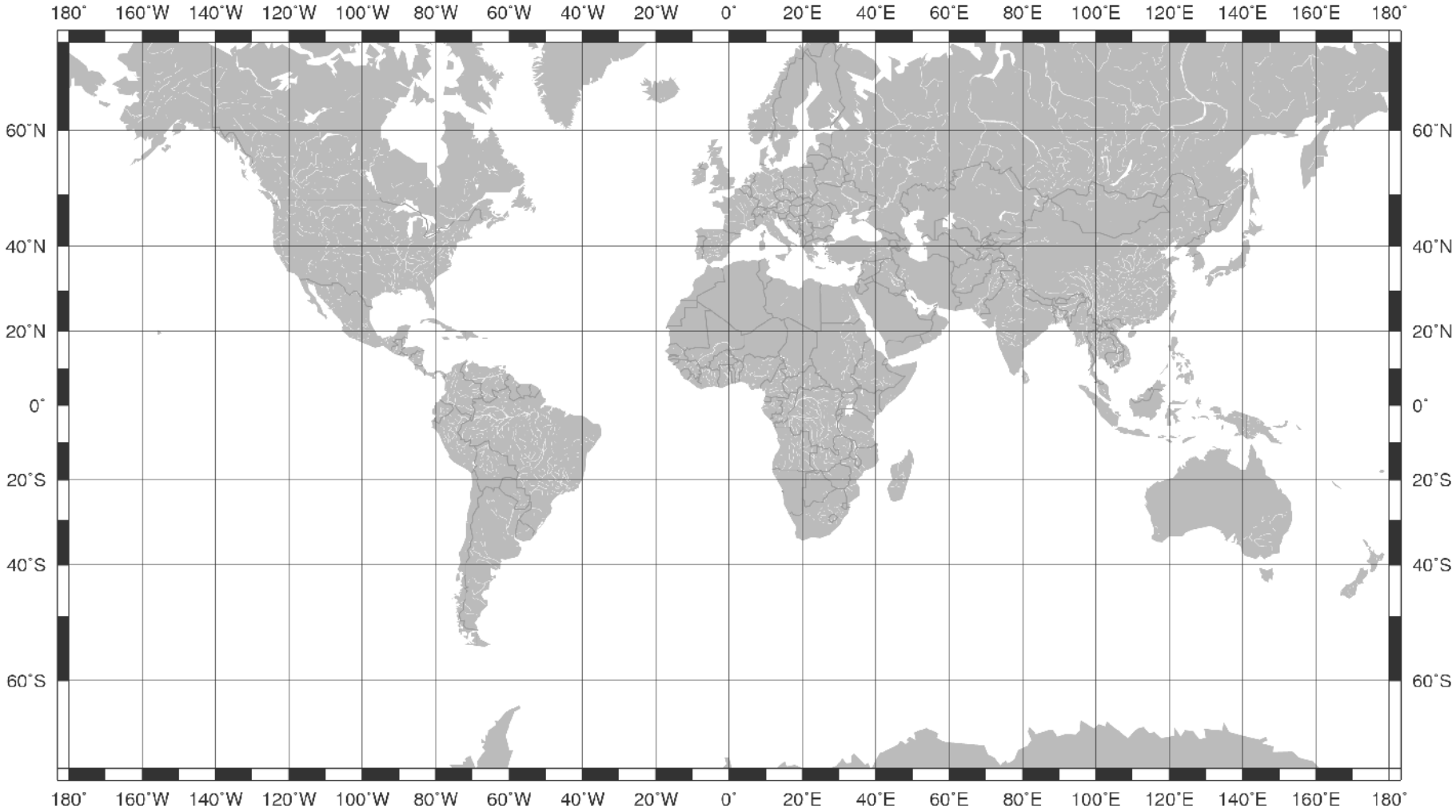
Teacher Master 1.1

World Coral Reef Locations



Student Master 1.2

World Coral Reef Locations



Student Master 1.2

World Coral Reef Locations (continued)

Directions: Locate each listed coral reef by latitude and longitude and mark it with an "X" on the map.

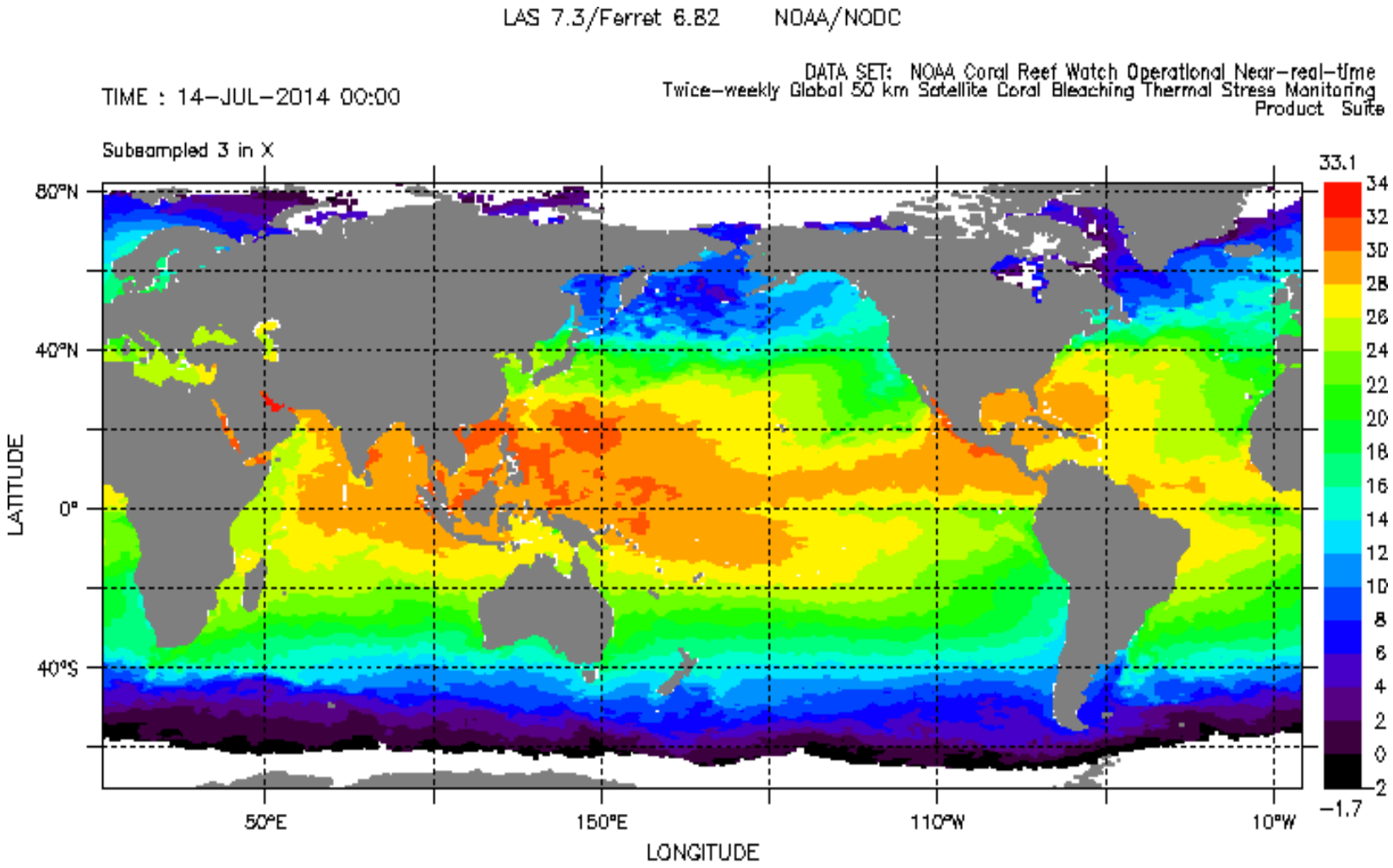
Location	Latitude	Longitude
Buzios, Brazil	22.5°S	41.5°W
Cayman Islands	19.5°N	80.5°E
Puerto Rico	18.0°N	67.5°W
Dry Tortugas, Florida	24.5°N	83.0°W
Galapagos, Ecuador	1.0°S	90.0°W
Hilo, Big Island, Hawaii	2.0°N	154.5°W
North Torres Reef, Great Barrier Reef	10.5°N	141.5°E
Red Sea	25°N	38°E

Questions:

1. Where are corals located?

2. Between what latitudes do most corals live?

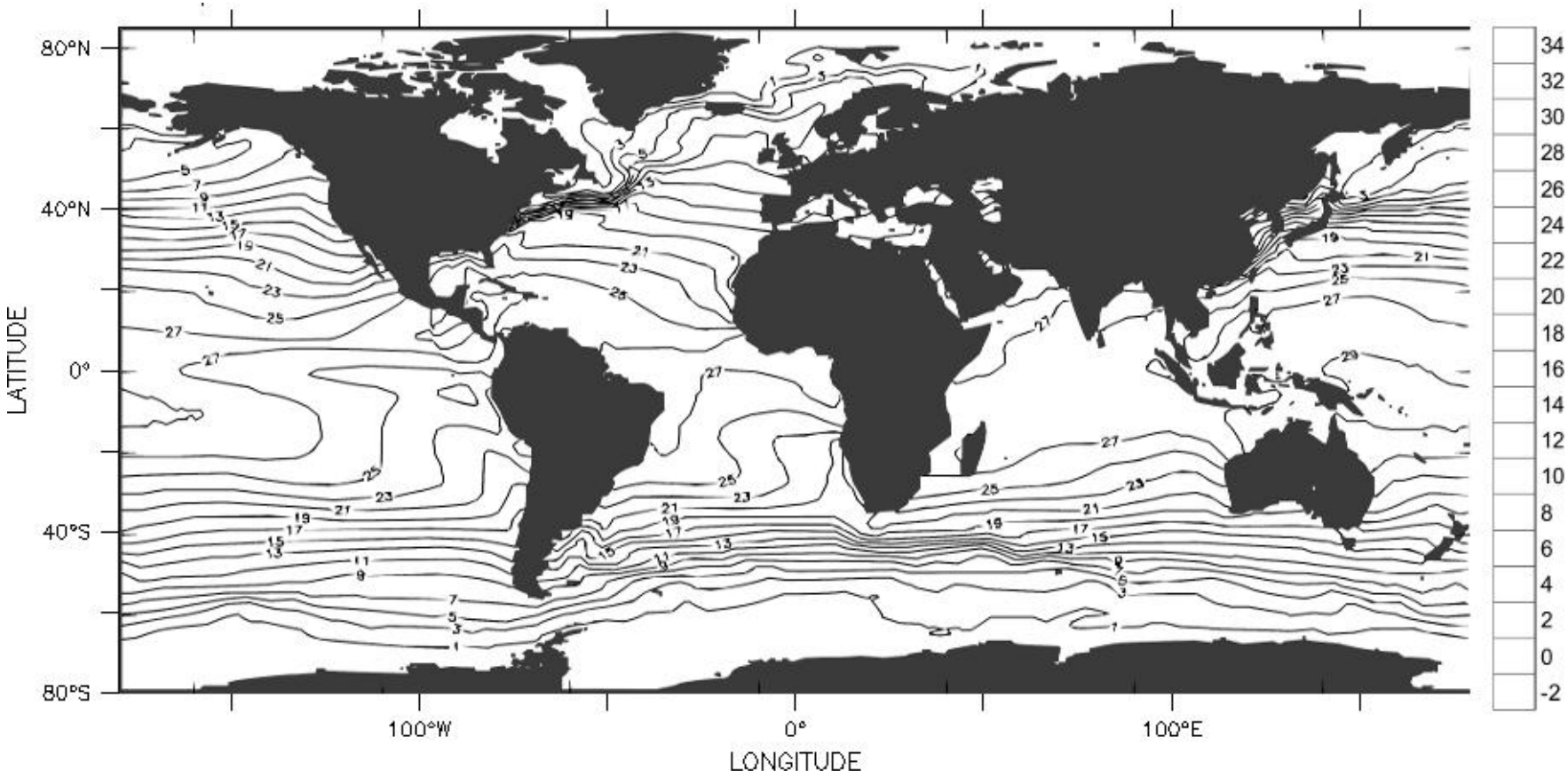
Monthly Average Sea Surface Temperature



Night Time Sea Surface Temperature (degrees Celsius)

Student Master 1.3

Monthly Average Sea Surface Temperature (with Isotherms)



1. Lines of latitude indicate:
a. degrees of temperature
b. degrees north and south of the equator
c. areas of equal temperature
d. representations of color to indicate temperature

2. What was the monthly average temperature at 160° E and 10°N?

3. What was the monthly average temperature along 100° W and 10° S

4. What is the range in monthly average temperature along the line 10°S between 150°E and 100°E?